

CONTINUATION APPLICATION

FOR

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TITLE: Z-AXIS ELECTRICAL CONTACT FOR
 MICROELECTRONIC DEVICES

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Z-AXIS ELECTRICAL CONTACT FOR MICROELECTRONIC DEVICES

This invention relates generally to electrical
5 contacts and techniques for the making the same and
particularly to techniques for making electrical contacts
for microelectronic devices such as integrated circuit
devices and contacts utilized with such devices.

Background of the Invention

10 A variety of devices are known for making Z-axis
electrical contacts. By "Z-axis" it is intended to refer to
an element which extends transversely to the plane of the
surface or surfaces to be contacted. One advantage of Z-
axis contacts is that they accommodate for irregularities in
15 one or more surfaces being contacted.

Metallic paste for forming electrical contacts has
been known for some time. For example, solder pastes
include conductive particles in a flux matrix. However,
solder pastes have little ability to provide Z-axis
20 connections because once heated they generally have little
or no structural integrity.

In a variety of modern electronic packaging used for
integrated circuits and other microelectronic devices, a
plurality of contacts on one electrical component may be
25 situated on contacts on another electrical component. In
the presence of heat, the contacts on one component may melt
or soften sufficiently to connect them to components on the
other device. Many of these connections are advantageous
because they occur in regions which could not be accessed
30 otherwise. For example, surface mount packages and ball
grid arrays may use this type of connection.

While these products may use conductive bumps, these
bumps generally cannot accommodate for a variety of
irregularities which may be encountered by contacts. One

problem faced with conventional contacts is that a good electrical connection may not be possible between two contacts because a native oxide film has formed over one or more of the contacts which prevents the electrical

5 connection. Another difficulty, described above, is that the contacting surfaces often are irregular so that good physical connection is not always possible.

Thus, there is a continuing need for a Z-axis contact which facilitates connection between surfaces which
10 may be irregular, which improves the connection in a variety of surfaces, and which at least in some cases, facilitates connection between surfaces which may be occluded by a native oxide layer.

Summary of the Invention

15 In accordance with one aspect of the present invention, an electrical contact for a microelectronic device includes a first contact pad and a resinous member having conductive particles. The member extends upwardly from the first contact pad.

20 In accordance with another aspect of the present invention, an electrical connection for a microelectronic device includes a first contact pad and a resinous member having conductive particles dispersed through the member. The resinous member has upper and lower ends. A second
25 contact pad is connected to the upper end of the member and the first contact pad is connected to the lower end of the member.

In accordance with yet another aspect of the present invention, an electrical contact for a semiconductor device
30 includes an annular member formed of conductive particles in a resinous matrix. The member is adapted to physically and electrically connect to conductive terminations.

In accordance with another aspect of the present invention, a method of electrically contacting a surface includes the step of depositing an annular member formed of conductive particles in a resinous matrix. The member is physically connected between a pair of conductive surfaces.

In accordance with but another aspect of the present invention, a method of making electrical contact includes the step of forming an upstanding conductive, annular member on a first contact surface. The member contacts a second contact surface. The member is heated to bond the member to the second contact surface.

In accordance with yet another aspect of the present invention, a stencil for forming a deposit for making electrical contact includes an annular opening formed in the stencil. At least one bridge element spans across the annular opening.

In accordance with another aspect of the present invention, a method of forming a deposit in making semiconductor devices includes the step of forming at least one annular opening in a plate to form an inner member inward of the opening and an outer member outward of the opening. A physical connection is maintained between the inner and outer members.

In accordance with but another aspect of the present invention, a resinous electrically conductive material includes a resinous body having an edge surface. A plurality of electrically conductive particles lap one another along the edge surface so as to form an electrically conductive path along the edge surface.

Brief Description of the Drawing

Fig. 1 is a partial top plan view of one embodiment of a stencil useful in connection with the present invention;

Fig. 2 is an enlarged cross-sectional view showing the stencil of Fig. 1 in position on a microelectronic device in the process of forming a Z-axis contact;

Fig. 3 is an enlarged cross-sectional view of a connection achieved by way of the Z-axis contact shown in Fig. 2;

Fig. 4 is an enlarged cross-sectional view of another Z-axis connection in accordance with an alternate embodiment; and

Fig. 5 is an enlarged photomicrographic depiction of a conductive resinous matrix useful in connection with the embodiments shown in the previous figures.

Description of the Preferred Embodiments

Referring to the drawing wherein like reference characters are used for like parts throughout the several views, a stencil 10 for forming a contact member is shown in Fig. 1. The stencil is illustrated as having an annular opening 12 spanned by bridging elements 14. Thus, the illustrated stencil 10 is capable of forming circular, annular deposits. The stencil 10 may be formed using conventional techniques used to form solder stencils. The stencil 10 may, for example, be laser cut or may be chemically etched. Other noncircular, closed annular shapes may be formed using stencils of the type illustrated in Fig. 1, with bridging elements 14.

Referring now to Fig. 2, the stencil 10 is shown in position atop support structure 16 which could be a part of a variety of microelectronic elements. Among the potential support structures 16 are a die or chip, a printed circuit board, or a flexible card. The support structure 16 includes a conductive contact pad 18 over which is situated the stencil 10. A resinous matrix with interspersed

conductive particles is forced through the stencil 10 using a squeegee blade 20 or the like to form the resinous member 22 in the form of an interrupted circular annulus. The resulting member 22, is annular and tapers in thickness as it extends upwardly.

A wide variety of materials may be used as the resinous conductive member 22. For example, a resinous matrix with metallic particles such as silver, nickel or iron flakes or gold plated nickel flakes may be utilized such that the conductive particles are capable of making the member 22 conductive.

As shown in Fig. 5, the conductive flakes 24 may coalesce or align along surface regions to form a conductive path comprised of a series of contacting conductive flakes. While the precise physical reason why these aligned particles are formed at surface regions is not known, it is believed that it may be a function of surface tension.

A wide variety of resinous matrices may be utilized including polymeric adhesives, epoxies, thermosetting, thermoplastic, and B-stagable resins which may not be fully cross-linked and other highly thixotropic resins. One particularly preferred resin is polyimide. It is advantageous since it is thermoplastic and may have a thixotropic index of 6 or greater. An advantageous viscosity range is 200,000 centipoise.

The thickness of the stencil and the resulting height of the member 22 is subject to considerable variation. Useful stencil heights include heights from about 3 to about 10 mils. Members 22 for flip chips may have a height range of approximately 3 mils.

The conductive particle size depends on the aspect ratio of the member 22. However, the particle lengths of 1/4 to 1 mil would be advantageous in connection with the

present invention. The loading factor of conductive particles is advantageously approximately 80%.

One suitable metal flake 24 is a silver flake available from NanoPowders Industries, L.C. of Bay Harbour Islands, Florida 33154. With these types of materials, an
5 annular stencil opening of approximately 1 mil measured radially is suitable.

With a thermoplastic material forming resinous member 22, as shown in Fig. 3, a bond pad 28 may be situated
10 atop the member 22. In this condition, the member 22 may be cured at a temperature above T_g which is the glassy transition temperature of the member 22. Above T_g the upper end 23 of the member 22 bonds to the bond pad 28.

Because of the pointed upper end 23 of the member
15 22, any remaining oxide on the contact surface of the bond pad 28 may be penetrated insuring a good electrical contact. In addition, if there are surface irregularities in the bond pad 28, those can be accommodated for during the softening of the member 22, again, to insure good electrical contact.
20 Particularly with aluminum bond pads, the potential for aluminum oxides to form on the surface of the bond pad is significant. Thus, the ability of the contact to make contact through that oxide is beneficial.

With thermosetting resinous matrices, it may be
25 necessary to hold the contact in place using additional adhesive. The additional adhesive (not shown) may be positioned around the member 22.

The stencil 10 may be provided with a large number of apertures which can simultaneously print a large of
30 number of members 22 on a variety of bond pads. For example, a semiconductor wafer can be printed with a large number of the conductive members 22 using conventional printing techniques well known to those of ordinary skill in

this field. Alternatively, pin transfer techniques may be utilized.

5 Instead of making direct contact with the bond pad 28, an intervening conductive bump 30 may be provided on the bond pad 28, as shown in Fig. 4. In this situation, the annular arrangement of the member 22 facilitates and guides the conductive bump 30 into alignment with the member 22.

10 While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations. For example, a plurality of concentric annular members 22 could be used. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of the present invention.

15 What is claimed is: